DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
ENGINEERING DIVISION

MONARTO NEW TOWN - PARAGUM STRATIGRAPHIC BORE : COMPLETION REPORT

Hd. Monarto : Sec. 266

- Monarto Development Commission -

by

J.SELBY

SENIOR GEOLOGIST

Rept.Bk. No. 75/41
D.M. No. 1119-74
G.S. No. 5579
Eng.Geol.No. 1972/17

12th March, 1975

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INTRODUCTION

A stratigraphic bore has been completed to a depth of 48.0m at Paragum Station, Monarto South (Fig. 1) by request of Messrs. Kinnaird Hill, de Rohan and Young, Consulting Engineers engaged by the Monarto Development Commission.

Drilling was carried out using a cable tool rig to obtain continuous drive tube samples according to the procedure outlined in Appendix II. Work commenced on 10th December 1974 and was completed by 17th December 1974 at a total cost of $2250.

Purpose of the bore was to investigate groundwater conditions and the existence of possible aquifers in connection with the Regional Hydrological Survey. It has also served to indicate foundation conditions beneath the proposed Sewage Treatment Works.

A detailed geological log is given in Appendix I.

PREVIOUS WORK

A seismic refraction survey was carried out in May 1974 (Ref. 1) in an attempt to predict depth to Kanmantoo Group bedrock to ensure that drilling did not take place over a bedrock high. Location of the seismic spreads is shown in Fig. 1.

Spread 1 showed a major high speed refractor at a depth of around 30 m which has proved to be the Mannum Limestone. Seismic refraction penetration below this horizon would be difficult due to the velocity inversion provided by the underlying Compton Conglomerate. The shallow velocity change at about 3 m suggesting the start of the hard Blanchetown Clay Member has not been confirmed accurately by the log.

It is interesting to note that results from the other seismic spreads indicate a slight northward dip of the Mannum Limestone in this area.

FOUNDATION CONDITIONS

A comparison between the engineering properties of the Hindmarsh clay and the Blanchetown Clay has been made by Stapledon (Ref.2). Foundation conditions in this area may be expected to resemble those in the Adelaide City area. Briefly this will imply shrink-swell movement of the clay which has a high bearing capacity, with the possibility of groundwater seepage at shallow depth through fissures. There is also some indication of gilgai "puff" structures in Section 264.

EXTRACTIVE MINERALS

Sieve analyses carried out on the sand member of the Blanchetown Clay Formation show that the material falls between the limits set by Australian Standard A.77 (Appendix I for results), and would therefore be suitable for concrete aggregate. Its depth however probably precludes economic development.

The overlying clay member is probably not suitable for brick construction due to its highly plastic nature.

Near Murray Bridge the Mannum formation is quarried as a source of limestone aggregate but would be too deep on this site for feasible development.

GROUNDWATER

Only one minor water seepage was struck at 36 m within the Mannum Limestone, rising slightly in the hole. The water was saline giving an Approximate Total Solids reading of 25 000 mg/l.

The 5m thick Sand member which was struck at 14.5m below ground was completely dry. This may be due to the confining effect of the overlying Blanchetown Clay. The sand layer would be suitable as a drainage aquifer although its permeability cannot be estimated reliably without test pumping.

J. SELBY
SENIOR GEOLOGIST

REFERENCES

Wightman W.E., Seismic Refraction Survey at Monarto. S.A.D.M. Rept.Bk. 74/100 (unpubl.)

Stapledon D.H., Changes and Structural Defects developed in some South Australian clays, and their Engineering Consequences. C.E. Trans. Inst. Engineers Aust. Vol. C.E9 No.1

APPENDIX I

Geological log & Sieve

Analysis results

6727-287

DEPARTMENT OF MINES – SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE NO. CH 1

SERIAL NO. 310/75

PROJECT MONARTO – PARAGUM. El. Collar — m

FEATURE STRATIGRAPHIC BORE SEC 266 HD MONARTO El. Surface 90·0 m

LOCATION 18 km SSE of Monarto South CO-ORDS 6108000N/330900E Datum A.H.D.

GEOLOGICAL NOTES AND CLASSIFICATION	El. / DEPTH m	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME (Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966)	WATER LEVEL	MOISTURE CONTENT	Consistency Compact Dens	FIELD TEST DATA: BLOWS PER 30 cm (4 8 16 32 64)	FIELD TEST DATA: SOIL TEST PENETROMETER Units * (1 2 3 4)
RECENT TOPSOIL — LOOSE AEOLIAN SAND	0		SP	SAND, poorly graded. Grains 0·2 to 0·5 mm		H	L		
VERY DENSE INTERBEDDED SAND and CLAY with carbonaceous rootlets	1		SC/CL	SAND, excess clay fines with CLAY, low plasticity Crumb texture		D	VD		Over 4
EQUIVALENT BLANCHTOWN CLAY — HARD MOTTLED CLAY	2		CH	CLAY SOIL, high plasticity. Shows crumb texture and yellow-brown mottling					
	3		SC	Thin SAND excess clay fines					
Nodules are calcareous material, SAND is ferruginous	4			Scattered white nodules and occasional thin sandy bands up to 5 cm thick		W PL	V. St. to H		Over 4
	5								
	6								
	7			Thin SAND (SC) layer					
Clay is uniform with occasional thin sandy layers	8			← Thin SAND (SC) layer < 2 cm think					
	9								
	10			Water added to hole →		< PL			Over 4
	11								
	12								
	13								
Carbonaceous material → DENSE MOTTLED SANDY CLAY	14		SC	SAND, excess clay fines. Yellow-brown mottled Non-calcareous		< PL	MD/D		
	15		SP	SAND, uniformly graded. Grains 0·2 to 1·0 mm		D	MD		
MEDIUM CLEAN SAND	16			●					
	17								
	18			●					
Grains are subrounded quartz	19			●					
	20			● SAMPLE TAKEN FOR SIEVE ANALYSIS					

WATER LEVELS	MOISTURE CONTENT	CONSISTENCY (Clays)	COMPACTNESS (Silts)	RELATIVE DENSITY (Sands)	TYPE OF SAMPLE
7 Dec. '66. Casing; Water level (date); WC Water Cut	H — Humid; D — Damp; M — Moist; W — Wet; S — Saturated; LL — Liquid Limit; PL — Plastic Limit	VS — Very Soft; S — Soft; F — Firm; St — Stiff; V.St — Very Stiff; H — Hard	Ls — Loose; MC — Moderately Compact; C — Compact; VC — Very Compact	VL — Very Loose; L — Loose; MD — Medium Dense; D — Dense; VD — Very Dense	OPEN TUBE A Shoe, D Shoe; SEALED TUBE WITH NUMBER (A 1 2 3 4 5); STANDARD PENETRATION TESTS 9 (2,3,4) Total blows for 0·3m (in 0·1m increments)

* These values refer to clay soils only and provide an indication of their consistency

ENGINEERING GEOLOGY SECTION

DRILL NO. 23 LOGGED BY J. Selby

TYPE DM 50 DATE 2-1-75

DRILLER T. Casson TRACED D.J.M.

START 10-12-74 CHECKED JS.

FINISH 17-12-74

SHEET 1 OF 3 DRG. NO. S11255

PF No S6676 b MB A4 6727 – IV

DEPARTMENT OF MINES – SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE NO. CH 1
SERIAL NO. 310/75

PROJECT MONARTO – PARAGUM. El. Collar — m
FEATURE STRATIGRAPHIC BORE SEC 266 HD MONARTO El. Surface 90·0 m
LOCATION 18 km SSE of Monarto South CO-ORDS 6108000N/330900E Datum A.H.D

GEOLOGICAL NOTES AND CLASSIFICATION	El.	DEPTH m	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME (Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966)	WATER LEVEL	Casing	MOISTURE CONTENT	Consistency Compct Densy	FIELD TEST DATA: BLOWS PER 30 cm (·4 8 16 32 64)	SOIL TEST PENETROMETER Units * (1 2 3 4)
BLANCHTOWN CLAY EQUIVALENT					GREY MEDIUM SAND (cont'd)						
	20			SW							
	21			SC	SAND, excess clay fines Yellow						
FINE SILTY AND CLAYEY SANDS	22			SW	SAND, well graded, grey. Grains, 0·2 to 1·0 mm			DRY TO HUMID	MD		
	23			SM	SAND, excess silty fines orange to yellow Grains, silt to 0·2 mm						
	24			SC	(becoming clayey)						
HARD MOTTLED SANDY CLAY Sand is ferruginous and gypsiferous	25			CH/SC	CLAY, high plasticity Mottled grey and yellow with sandy partings			V PL	H		Over 4
	26										
	27										
	28				gypsum crystals are about 2% and <0·5mm						
	29										
MANNUM FORMATION	30			GP	SLUDGE, samples of brown sand and rock chips – highly disturbed			ROCK	DRILLED WITH CHISEL		
MEDIUM STRONG FRESH SHELLY LIMESTONE	31										
	32										
	33			GP	GRAVEL, poorly graded gravel, sand, silt mixture			I	D		
Limestone is brown and sandy, with bands of dense gravelly material	34				SLUDGE, samples as above			ROCK	DRILLED WITH CHISEL		
	35										
	36					WC					
	37			SP	Basal Sand layer			W	MD		
COMPTON CONGLOMERATE	38			GM	GRAVEL, sand, silt mixture			W	MD		
MEDIUM DENSE SHELLY GRAVEL Yellow mottling is calcareous	39				Black with yellow mottling and abundant shell gravel						
	40										

WATER LEVELS	MOISTURE CONTENT	CONSISTENCY (Clays)	COMPACTNESS (Silts)	RELATIVE DENSITY (Sands)	TYPE OF SAMPLE
7 Dec. '66. Casing; Water level (date); WC Water Cut	H — Humid; D — Damp; M — Moist; W — Wet; S — Saturated; LL — Liquid Limit; PL — Plastic Limit	VS — Very Soft; S — Soft; F — Firm; St — Stiff; V.St — Very Stiff; H — Hard	Ls—Loose; MC—Moderately Compact; C — Compact; VC—Very Compact	VL — Very Loose; L — Loose; MD—Medium Dense; D — Dense; VD — Very Dense	OPEN TUBE ..... A Shoe ..... D Shoe; SEALED TUBE WITH NUMBER A 1 2 3 4 5; STANDARD PENETRATION TESTS 9 (2,3,4) Total blows for 0·3m (in 0·1m increments)

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL NO. 23 LOGGED BY J. Selby
TYPE D.M. 50 DATE 2-1-75
DRILLER T. Casson TRACED D.J.M.
START 10-12-74 CHECKED JS
FINISH 17-12-74
SHEET 2 OF 3 DRG. NO. S11255 – a

PF No S6676 b MB 6 2 – 1

DEPARTMENT OF MINES – SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE NO. CH 1

SERIAL NO. 310/75

PROJECT MONARTO – PARAGUM . . . . . El. Collar —. m

FEATURE STRATIGRAPHIC BORE . . . . . SEC 266 HD MONARTO . El. Surface 90·0 m

LOCATION 18 km SSE of Monarto South CO-ORDS 6108000 N / 330900 E . Datum A.H.D.

GEOLOGICAL NOTES AND CLASSIFICATION	El. DEPTH m	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966	WATER LEVEL Casing	MOISTURE CONTENT	Consistency Compct Denssy	FIELD TEST DATA: BLOWS PER 30 cm (4 8 16 32 64)	FIELD TEST DATA: SOIL TEST PENETROMETER Units * (1 2 3 4)
KANMANTOO GROUP (WEATHERED ZONE) COMPACT MICACEOUS SILT. Silt shows steeply dipping laminations and relict bedrock structures. (gradational)	40 41 42 43 44 45		MH	SILT SOIL, high plasticity. Grey-brown, silvery. Sticks to hand when wet, but cannot be moulded. Silt will be SENSITIVE		D H H	C VC VC		Variable 2½ to 4
VERY WEAK WEATHERED PHYLLITE	46 47 48			Sludge samples of flat grey-green rock chips and sandy silt	DRY		ROCK	DRILLED WITH CHISEL	
				END OF BORE 48·0 m					

WATER LEVELS	MOISTURE CONTENT	CONSISTENCY (Clays)	COMPACTNESS (Silts)	RELATIVE DENSITY (Sands)	TYPE OF SAMPLE
7 Dec. '66. Casing; Water level (date); WC Water Cut	H — Humid D — Damp M — Moist W — Wet S — Saturated LL — Liquid Limit PL — Plastic Limit	VS — Very Soft S — Soft F — Firm St — Stiff V St — Very Stiff H — Hard	Ls — Loose MC — Moderately Compact C — Compact VC — Very Compact	VL — Very Loose L — Loose MD — Medium Dense D — Dense VD — Very Dense	OPEN TUBE: A Shoe, D Shoe SEALED TUBE WITH NUMBER (A 1 2 3 4 5) STANDARD PENETRATION TESTS: 9 (2,3,4) Total blows for 0·3m (in 0·1m increments)

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL NO 23 . . . LOGGED BY J. Selby

TYPE DM 50 . . . DATE 2-1-75

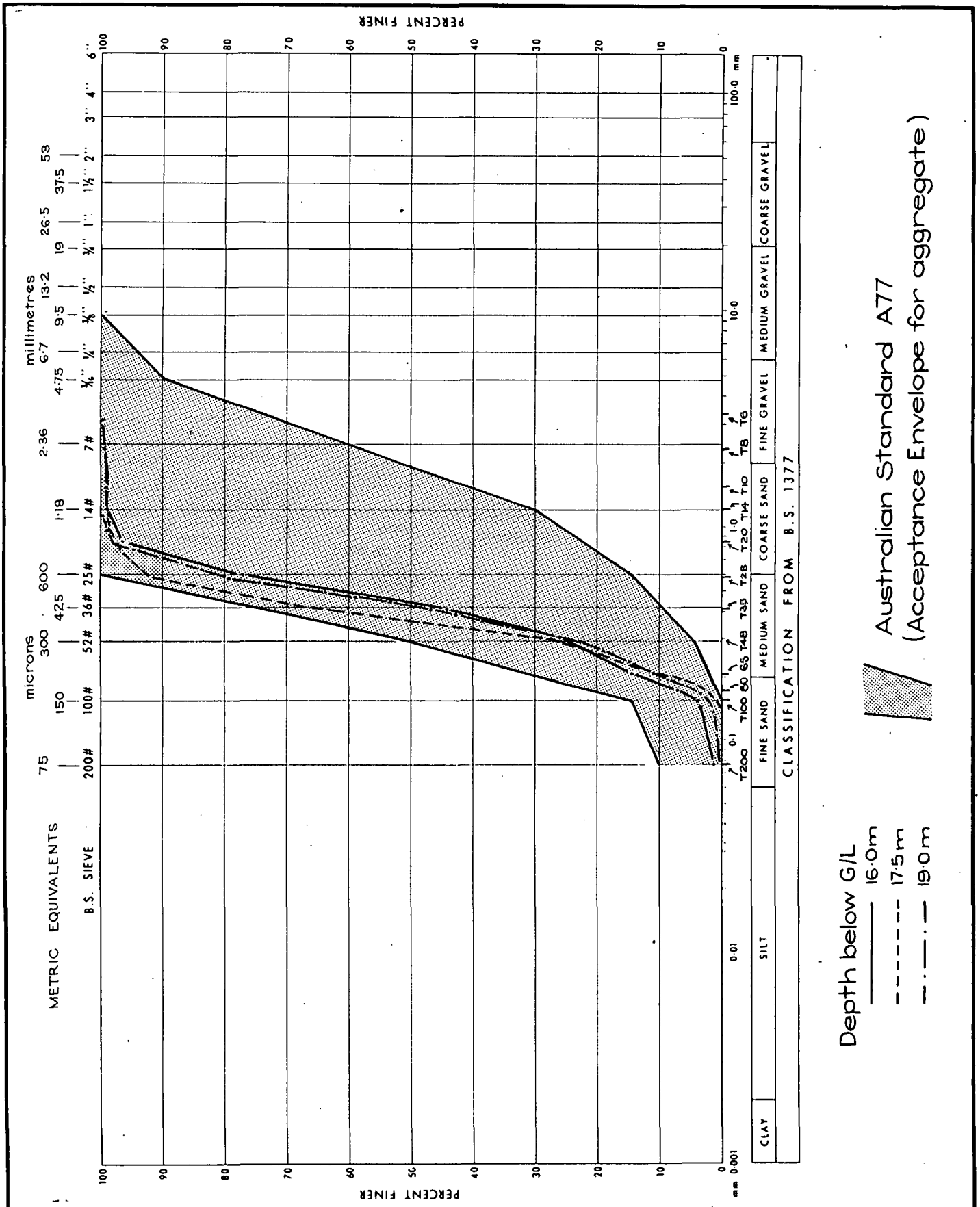
DRILLER T. Casson . . . TRACED D.J.M.

START 10-12-74 . . . CHECKED JS

FINISH 17-12-74 . . .

SHEET 3 OF 3 . DRG. NO. S11255 – b

PF No S6676 b MB A4 6727 – IV



ENGINEERING GEOLOGY SECTION	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: As shown
Compiled: J.Selby	MONARTO-PARAGUM STRATIGRAPHIC BORE SIEVE ANALYSIS OF SAND FORMATION IN CH.I.	Date: 14-3-75
Drn: J.W.		FIG:
Ckd:		Drg No. S11256

PF N9 S9548 MG

APPENDIX II

Cable Tool Drilling Proceedure and Descriptive Terms.

NOTES ON CABLE TOOL DRILLING PROCEDURES

Equipment

Drilling is carried out with a cable tool drilling plant using sampling tubes with special cutting shoes attached, through a vacuum head, to the sampling tools.

Continuous samples for logging purposes are taken with a heavy duty galvanised steel "S" tube (ID 106.5 mm). Sealed samples for laboratory testing are obtained with a special "L" type thin walled, cadmium plated steel tube and cutting shoe (ID 101.6 mm or 4 ins.) designed to reduce sample disturbance to a minimum.

Continuous Sampling Procedure

The "S" tube assembly, fitted with an "A" type cutting shoe (ID 103.2 mm), is lowered to the bottom of the hole and the tube is driven exactly 30 cm. The number of blows required for the 30 cm penetration is recorded.

Sample, or core, is extracted from the "S" tube using a hydraulic ram. This extracted core is sealed in a labelled plastic bag and stored in a core box.

The hole is reamed with a "D" shoe (ID belled out to 124.5 mm) and then the next sample is taken, using the same procudure as above. Thus the hole proceeds by alternate sampling, reaming and (where required) casing operations and the samples form a nearly continuous record of the materials penetrated.

In loose saturated material such as wet sand, a copper "basket" is inserted in the "S" tube above the cutting shoe to help retain the sample.

Sealed Tube Sampling Procedure

Before the sample is taken the hole is cleaned out to the depth specified. The hole is not reamed or cased for at least 30 cm from the bottom however, because these operations can cause considerable disturbance in the soil below. The sampling assembly is lowered carefully to the bottom of the hole, the sampling tube driven exactly 30 cm, and the number of blows recorded.

The sample is sealed in the tube by inserting in each end plastic seals with rubber sealing rings, and the tube is then labelled and stored in a Laboratory Sample Box.

The copper "basket" is never used during sampling for sealed tubes because of its marked disturbing effect on the sample.

Standard Penetration Test (SPT)

The Standard Penetration Test (Terzaghi and Peck 1967) is used to test the in-situ density of sands and to give an indication of the consistency of clays, and compactness of silts. However the test results can be affected by several geological factors such

as degree of cementation, and size and shape of grains. In loose saturated ground the test underestimates the consistency of the material due to piping effects, and under these conditions the drillers are instructed to stabilise the water level before testing. These factors should be taken into account in interpretation of results.

Equipment consists of a 5.1 cm (2 in.) diameter sampling tube and a hammer having a standard weight of 64 kg (140 lbs). The hammer is allowed to fall on the drill rods until the sampling shoe has penetrated 15 cm into the soil. The standard Penetration Number (N) is the number of blows required to produce the next 30 cm of penetration.

NOTES ON CABLE TOOL DRILL LOG SHEETS

During logging, soils are classified and described according to the Unified Soil Classification (USBR, 1966) which assigns letter symbols to each soil group.

Consistency, compactness and relative density of the soil is assessed from the results of the continuous blow count and SPT'S. This information is plotted in the form of a continuous histogram in the Field Test Data Column which also distinguishes various types of sample with a hatching code shown at the bottom of the log sheet.

In the column at the far right of the log sheet, readings of unconfined compressive strength (qu) made with a Soiltest Penetrometer, are recorded. The readings are plotted as a histogram. The Soiltest Penetrometer only gives true values of qu when used in clays in which $\phi = 0$.

(January, 1974)

REFERENCES

TERZAGHI, K. and PECK, R.B., 1967. Soil Mechanics in Engineering Practice, (2nd Edition). John Wiley and Sons.

UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION, 1966. Earth Manual, (2nd Edition).

DESCRIPTIVE TERMS

1. CLAY SOILS

CONSISTENCY

CONSISTENCY	SYMBOL	UNCONFINED COMPRESSIVE STRENGTH (kg/sq. cm)	FIELD TEST	N
Very soft	V.S.	Less than 0.25	Easily penetrated several centimetres by fist.	2
Soft	S.	0.25 to 0.5	Easily penetrated several centimetres by thumb	2 to 4
Firm	F	0.5 to 1.0	Can be penetrated several centimetres by thumb with moderate effort.	4 to 8
Stiff	St	1.0 to 2.0	Readily indented by the thumb but penetrated only with great effort.	8 to 15
Very Stiff	V.St.	2.0 to 4.0	Readily indented by thumb nail.	15 to 30
Hard (Extremely stiff)	H	over 4.0	Indented with difficulty by thumb nail.	30 and over

Based partly on Terzaghi, K. and Peck, R.B., 1966. Soil Mechanics in Engineering Practice, Wiley - New York.

MOISTURE CONTENT

ABBREVIATION	MEANING
MC $\simeq$ LL	Moisture content near liquid limit.
MC < LL	" " less than liquid limit.
MC > PL	" " greater than plastic limit.
MC $\simeq$ PL	" " near plastic limit.
MC $\leqslant$ PL	" " less or equal to plastic limit.
MC < PL	" " less than plastic limit
MC << PL	" " much less than plastic limit.

2. SILT SOILS

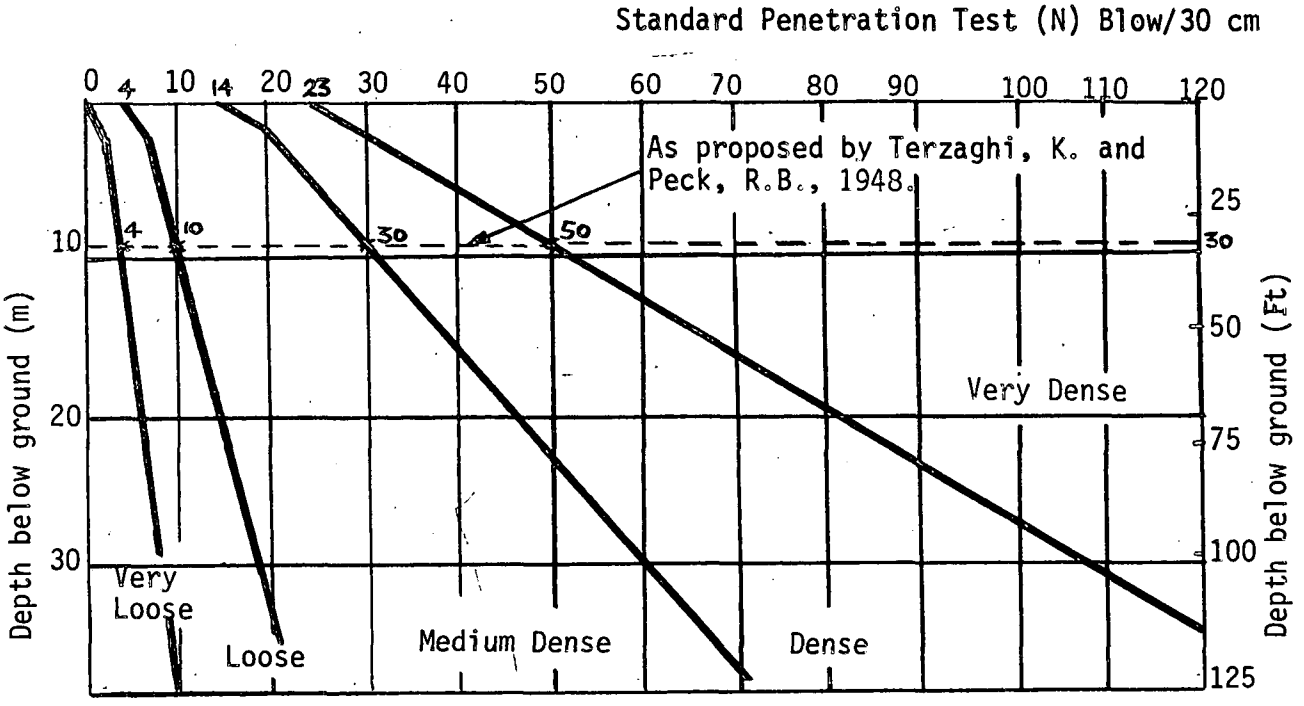
COMPACTNESS	SYMBOL	N
Loose	Ls	0 to 8
Moderately compact	MC	8 to 15
Compact	C	15 to 30
Very Compact	VC	greater than 30

3. SANDS

CLASSIFICATION OF SANDS BY STANDARD PENETRATION TEST

The relative density of granular soils has been judged from the results of Standard Penetration Tests carried out by the procedure described by Terzaghi and Peck (1948) bearing in mind the limitations of the method as discussed by Gibbs and Holtz (1957). At all times the water in the drill hole was kept at the level of surrounding groundwater.

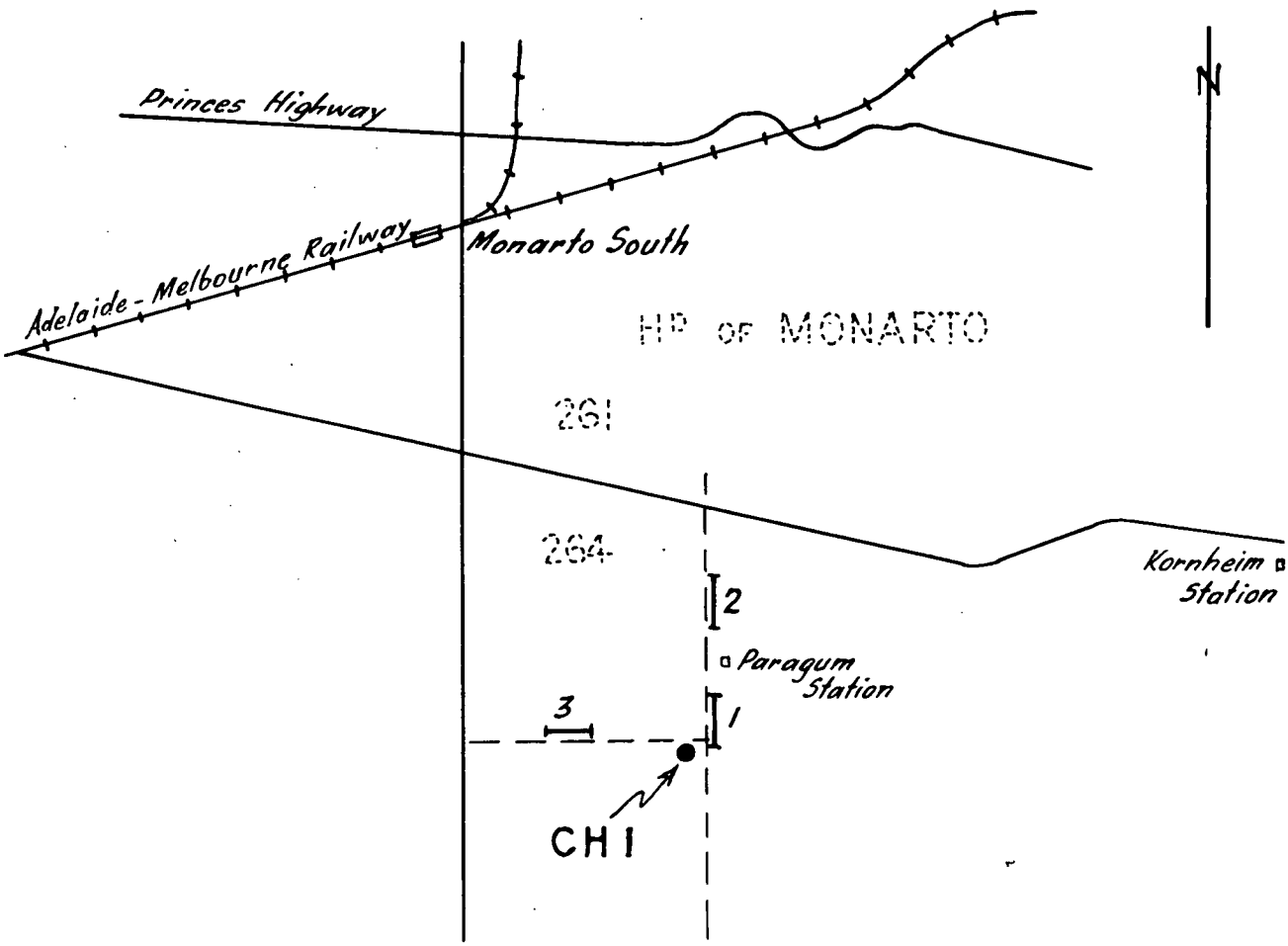
EFFECT OF OVERBURDEN PRESSURE ON STANDARD PENETRATION TEST



REFERENCES

Terzaghi, K. and Peck, 1948. "Soil Mechanics in Engineering Practice". Wiley, New York.

Gibbs, H.T. and Holtz, W.G., 1957. Research on Determining the Density of Sands by Spoon Penetration Testing. Proc. 4th Inter. Conf. SM & FE, London, Vol. 9.



Seismic refraction spreads shown 2

Refer Report Book 74/100 by W. E. Wightman.

Fig. 1

DEPARTMENT OF MINES — SOUTH AUSTRALIA

6727 - IV	Drn.	MONARTO PROPOSED SEWAGE TREATMENT WORKS LOCATION OF PARAGUM CHI STRATIGRAPHIC BORE	SCALE: Sketch
Compiled J. Selby	Tcd. BSG		S 11257
	Ckd.		
	Exd.		DATE: 17 · 1 · 75

500–2.69 665